

# MEHANIZACIJA ZA GRAĐENJE PUTEVA

Predavanje 7.2

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# MEHANIZACIJA

Osnovna podjela mehanizacije je prema operacijama rada u niskogradnji:

Proizvodnja materijala

- Iskop
- Utovar
- Transport
- Ugrađivanje i završna obrada
- Zbijanje
- Kolovozna konstrukcija
- Ostalo

# 1. Proizvodnja materijala

To su postrojenja ili oruđa za preradu prirodnih materijala (zemljani i stijenski materijali) i proizvodnju materijala spremnih za ugrađivanje (asfalt, beton).



Kamenolom



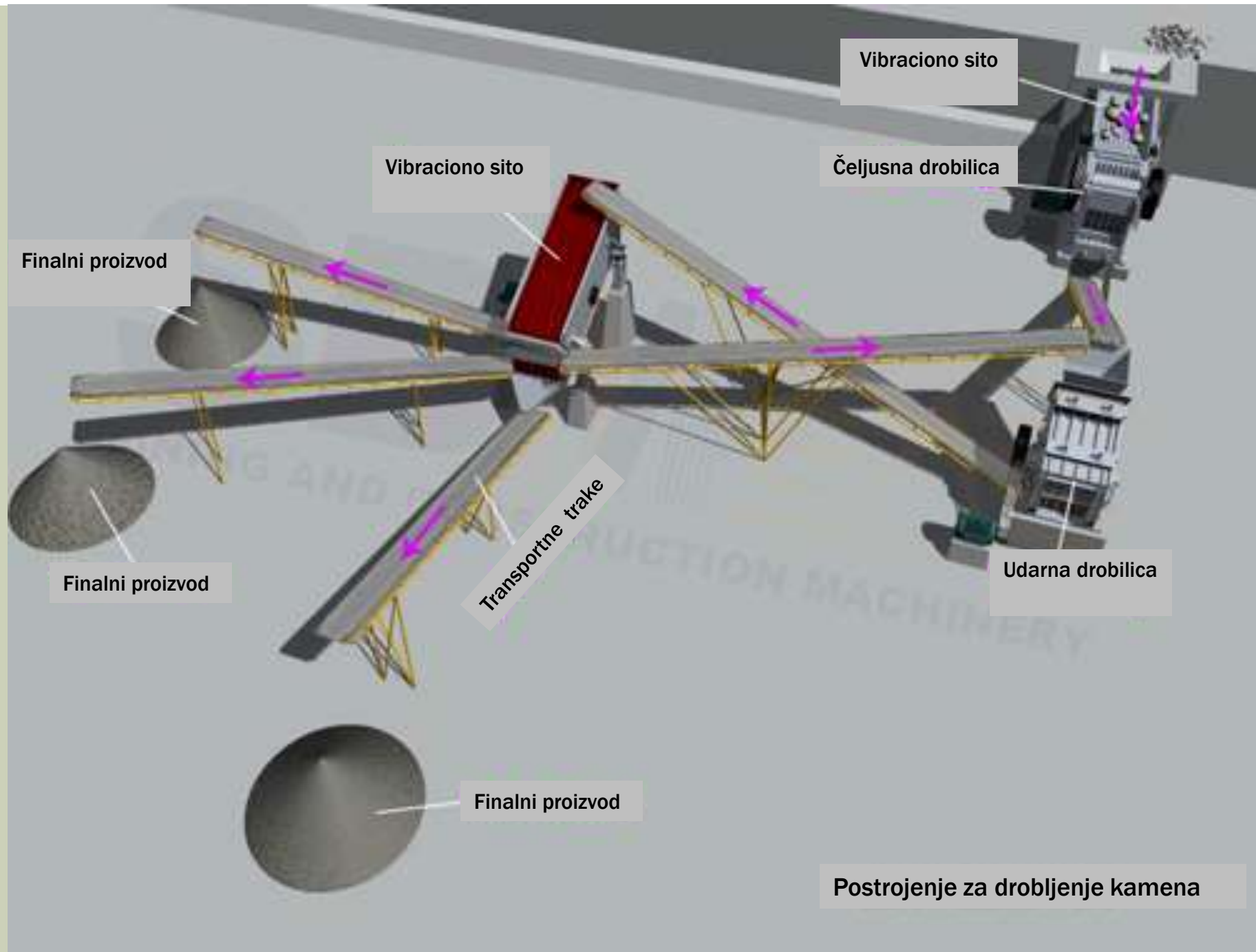
Mobilna  
drobilica



Stabilno  
drobilišno  
postrojenje







Postrojenje za drobljenje kamena



**KAMENOLOM SA DROBILIŠNIM POSTROJENJEM**





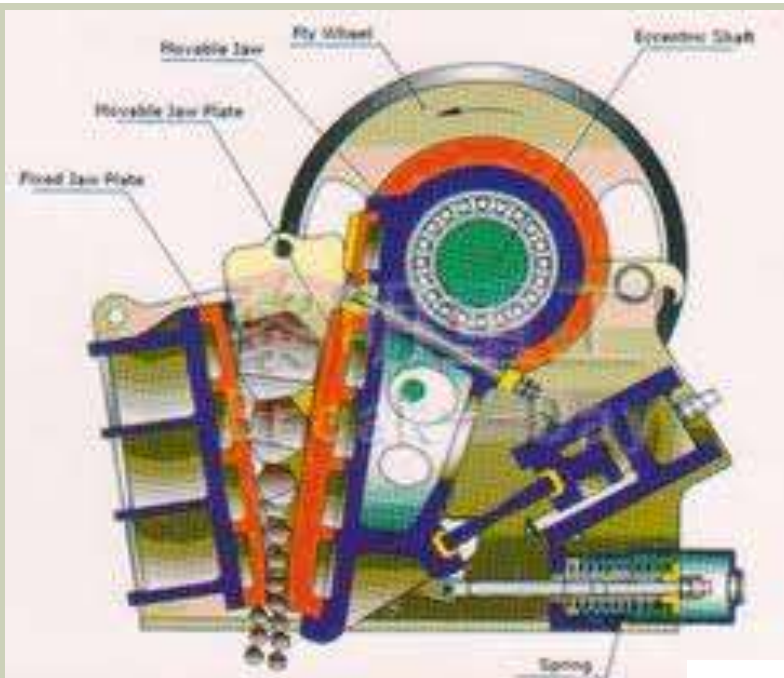
**KAMENOLOM SA DROBILIŠNIM POSTROJENJEM**



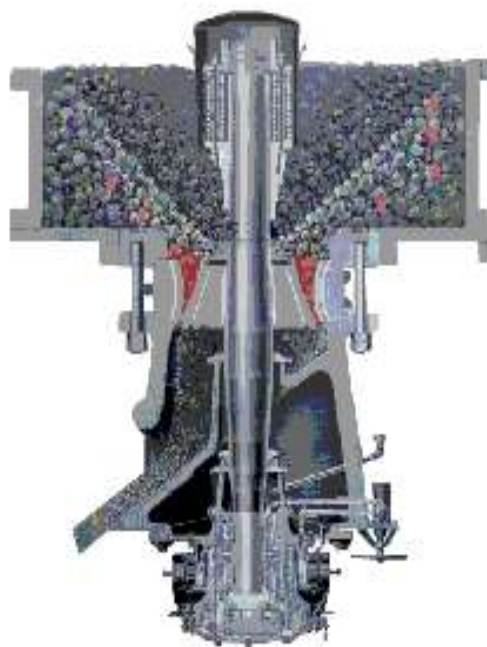


**DROBILIŠNO POSTROJENJE, gotovi proizvodi**

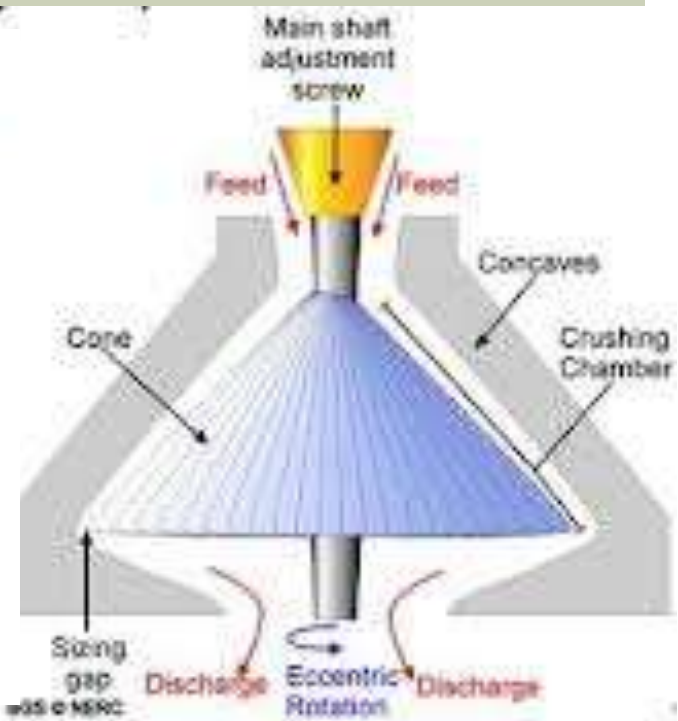




Čeljusna drobilica



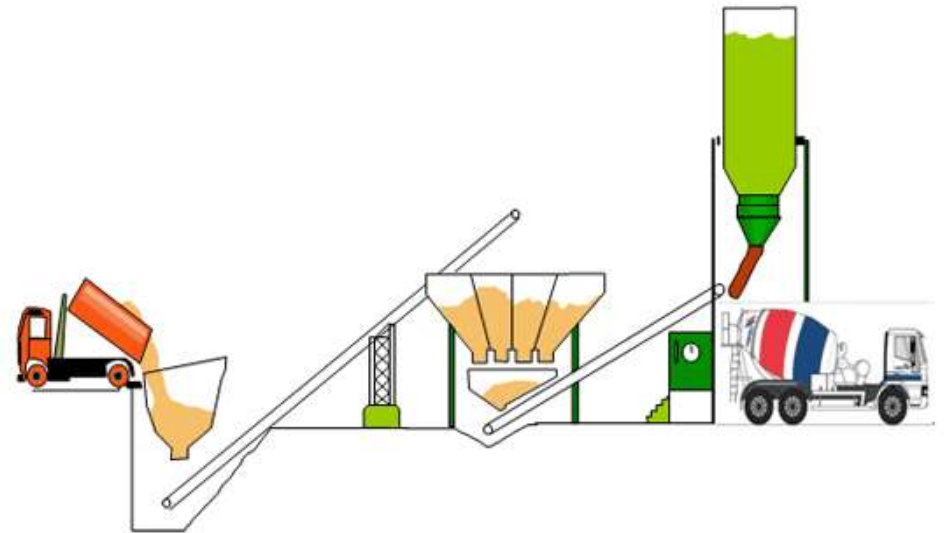
Konusna drobilica



## ASFALTNA BAZA



## BETONSKA BAZA





# MAŠINE ZA ZEMLJANE RADOVE

## 1. Iskopi



**BULDOZER**

**BULDOZER SA  
RIPERIMA**



**Bager sa dubinskom kašikom**



**Bager sa zahvatnom kašikom**







**Bager sa povlačnom kašikom - skrejper**



**Bager sa zahvatnom kašikom - grajfer**







**Skrejper**



**Grejder**



Utovarivač







Rovokopač





## TRANSPORTNA SREDSTVA





Čelični valjak



Valjak sa ježom



Kombinovani valjak



Pneumatski valjak





**Rotacijski mikser**



**Glodalica (freza)**





**FINIŠER**



## **ORGANIZACIJA I IZVOĐENJE RADOVA**

1. Pripremni radovi
2. Zemljani radovi i temeljenje
3. Kolovozne konstrukcije
4. Odvodnjavanje
5. Završni i zanatski radovi
6. Saobraćajna oprema i signalizacija

## **PLAN ORGANIZACIJE RADOVA**

Definišu se:

- Vrijeme i rok početka/završetka radova
- Priliv i trošenje finansijskih sredstava
- Resursi (mekanizacija, materijali, radna snaga....)

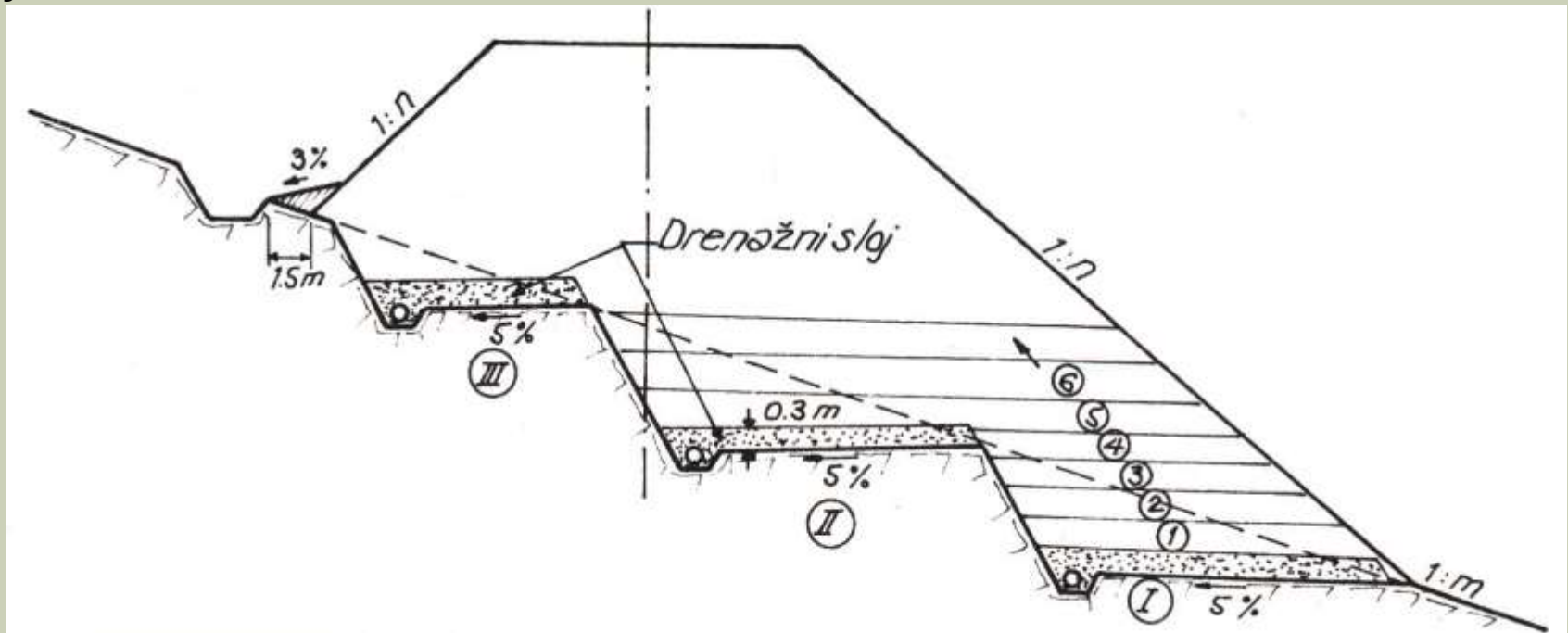
Kod izgradnje puteva dionice se određuju prema obimu radova, vrsti radova, težini izvršenja, preprekama koje treba savladati, tehnološkim zahtjevima i sl.

## 1. PRIPREMNI RADOVI

**Niz radova koji omogućava uvođenje izvođača u posao i pripremu za obavljanje glavnih građevinskih radova (obilježavanje trase i objekata, čišćenje i priprema terena, regulisanje vodotoka, rušenje i uklanjanje starih objekata, uređenje i otvaranje pozajmišta, određivanje deponija materijala, izgradnja prilaznih puteva, izbor mjesta i uređenje sjedišta gradilišta sa pratećim objektima – smještaj osoblja, radionice, skladišta, garaže, laboratorije...)**

## 2. ZEMLJANI RADOVI I TEMELJENJE

**Iskopi, nasipanje, obrada temeljnog tla, zaštita kosina, ojačanje tla, temeljenje objekata**





### 3. KOLOVOZNE KONSTRUKCIJE

Svi slojevi kolovoznih konstrukcija se ugrađuju mehanizovano, u novije vrijeme

finišerima – bez obzira na vrstu materijala

Podloga mora biti izvedena po odgovarajućim

pravilima, ravnost i zbijenost po standardima

Fleksibilne KK – vezivo bitumen

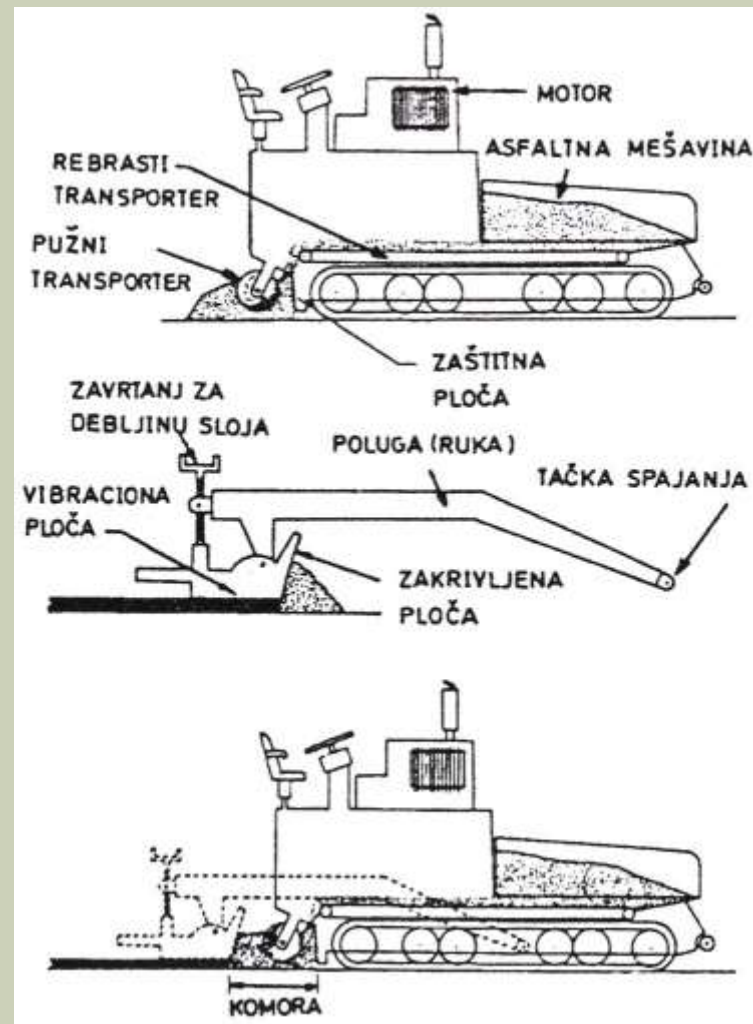
Krute KK – vezivo cement

#### Finišeri

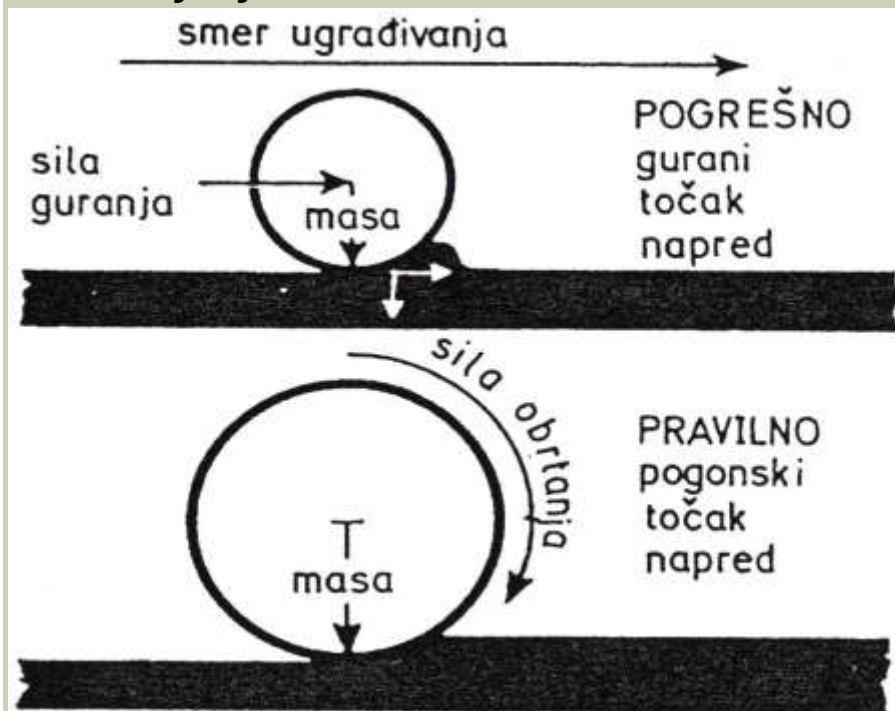
- Radna brzina od 0,5 do 16 m/s
- Širina ugrađivanja od 2 do 12 m
- Debljina slojeva od 2 do 30 cm
- Kapacitet od 150 do 800 t/h

#### Pravila valjanja

- Max brzina 5 km/h (8 za pneumatske)
- Najmanje dva valjka
- Stalno kvašenje točkova
- Od niže ka višoj tački
- Neposredno po razastiranju sloja
- Ravnomjerna brzina
- Preklop max 15 cm



- **Početno valjanje** – intenzivno sabijanje sloja pri što je moguće višoj temperaturi, statički i tandem vibro valjak (pneumatski za deblje slojeve), ivica se valja nakon 15 min da ne bi došlo do istiskivanja materijala
- **Glavno valjanje** – potpuno sabijanje sloja, razmak valjaka od 50 do 150m, pneumatski i tandem vibro valjci; radi se odmah nakon početnog valjanja dok je masa još plastična
- **Završno valjanje** – popravljjanje ravnosti površine, statički ili vibracioni teški tandem valjak – doke je mješavina još topla da se poprave tragovi glavnog valjanja





#### 4. ODVODNJAVANJE

Izrada sistema za površinsko i podzemno prikupljanje i odvođenje vode i provođenje vode kroz trup puta

#### 5. ZAVRŠNI I ZANATSKI RADOVI

Tesarski radovi, armirački radovi, zidarski i kamenorezački radovi, antikorozivni radovi, bravarski radovi, hidroizolaterski radovi....

#### 6. SAOBRAĆAJNA OPREMA I SIGNALIZACIJA

Vertikalna i horizontalna saobraćajna signalizacija



## UTICAJ RADOVA NA OKOLINU

U vezi sa izvođenjem građevinskih radova, prema konceptu održivog razvoja a na bazi standarda ISO 14000, izvođač je dužan da u svoj sistem rukovođenja ugradi mehanizam zaštite okoline od uticaja građevinskih radova (tehnoških procesa, materijala, mašina, radnika) i egzistencije gradilišta – tvornice pod otvorenim nebom – na okolinu.

Taj mehanizam treba da sadržava (prethodnu) procjenu uticaja (istraživanje i evaluacija aspekata uticaja), te Studiju utjecaja (kvanitifikacija uticaja i prijedlog mjera za smanjenje i otklanjanje tih uticaja).

Izvođač radova mora minimizirati utjecaje na okolinu kroz dvije grupe mjera: organizacione i tehničke.

## ORGANIZACIONE MJERE

Sistemske organizacione mjere upravljanja okolinom su:

- vlastita politika organizacije bazirana na standardima zaštite okoline,
- identifikacija aspekata okoline (okvirni zadaci) na bazi proizvodne aktivnosti organizacije sa rangiranjem uticaja po važnosti,
- identifikacija relevantnih zakonskih i regulativnih zahtjeva,
- uspostava prioriteta djelovanja - pogodnih operativnih zadataka,
- programi i organizaciona struktura za sprovođenje politike i operativnih zadataka,
- implementacije, nadziranje, evidentiranje i sprovođenje korektivnih mjera;
- zapisi; periodična procjena i pregled aktivnosti
- obavješćavanje javnosti o postignutom napretku



# TEHNIČKE MJERE

## A. OPIS UTICAJA U TOKU GRADNJE:

1. na stanovništvo / socio-ekonomski utjecaji (vibracije, buka, raseljavanje, promjena saobraćajne infrastrukture spram kvaliteta života)
2. na floru
3. na faunu
4. na površinske i podzemne vode
5. na zemljište (tlo i geomorfologija)
6. na klimatske faktore (promjena mikroklima)
7. kvalitet zraka
8. na materijalna dobra (i kulturno-historijsko i arheološko naslijeđe)
9. na pejzaž
10. na okolinske/ekološke nesreće (rizik njihovog nastanka).

## B. OPIS MJERA UBLAŽAVANJA UTICAJA TOKOM GRADNJE:

Posebno je važno da se predložene tehničke mjere otklanjanja/smanjenja uticaja ugrade u odgovarajuće dijelove projekta građenja (naročito tehničko- tehnološke postupke, ali i organizaciona rješenja radnih mjesta, radilišta, nabavke, transporta i sl.).

# KONTROLA KVALITETA

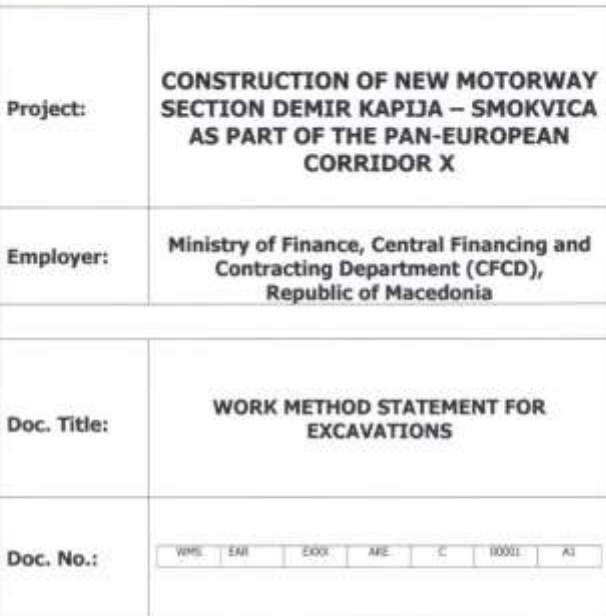
Provjera kvaliteta kod pripreme – proizvodnje, prevoza i izvođenja građevinskih radova

Sistem kvaliteta u građenju puteva – obezbjeđenje odgovarajućih tehničkih uslova

## Tehnički uslovi:

- Opis pozicije rada
- Osnovni materijali – kvalitet materijala
- Kvalitet izrade
- Kontrola kvaliteta
- Mjerenje i preuzimanje radova
- Obračun i plaćanje radova
  
- Terenska i laboratorijska ispitivanja i odgovarajuća analize (norme, standardi...)
- Probna proizvodnja i ugradnja – dokazivanje kvaliteta
- Obezbjeđuje se unutrašnjom i vanjskom kontrolom.
- **Unutrašnja kontrola** – izvođač radova izvršava sva ispitivanja koja su potrebna za provjeru kvaliteta materijala, tehnologije i izvođenja radova
- **Vanjska kontrola** – nadzor nad unutrašnjom kontrolom
- **Laboratorija** – Izvođač obezbjeđuje laboratoriju koja mora zadovoljiti sve potrebe unutrašnje kontrole
- **Nadzor** – provjerava se da li se izgradnja izvodi u skladu sa glavnim projektom





	<b>NAME</b>	
<b>PREPARED BY:</b>	Christos Zarkadis	
<b>REVIEWED BY:</b>	Dimitris Kavouropoulos	
<b>APPROVED BY:</b>	Konstantinos Simou	
<b>DATED</b>	20/02/2013	

CONSTRUCTION OF NEW MOTORWAY SECTION DEMIR  
CAPDIA - SMOLVICA AS PART OF THE PAN-EUROPEAN CORRIDOR X

## Table of Revisions

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## 1. PURPOSE

Definition of the operations to be carried out in order to implement the controlled, open air excavation of the site using mechanical means as well as the site levelling in order to start with the works, with other subsequent excavations or with the leveling work, and the subsequent transport of the removed material to deposits, dumps or handling premises.

## 2. SCOPE

The procedure describes all actions to be taken in order to assure the effective project execution in the field of earthworks

## 3. REFERENCES

- Contract Agreement
- Technical Specifications
- Quality Management System (QMS)
- Safety Plan for Excavation Works
- Design Drawings and Specifications

## 4. RESPONSIBILITIES

List all means required for execution, in particular:

- Earth Works Engineer (1)
- Geologist (1)
- Surveyor Engineer (1)
- Quality Engineer (1)
- Laboratory Engineer
- Foreman (1)

## 5. EQUIPMENT

All machinery indicated can be modified or changed for similar equipment. All equipment must be operated and maintained by skilled personnel.

- Bulldozers (6) (Types: CAT D8, CATD9N, D10)
- Excavators (6) (Types: CAT LEIBHER, KOMATSU)
- Loaders (6) (Types: CAT 950G, CAT 980F, CAT 988F)
- Dumper trucks (6) (Types: TEREX TR60)
- Trucks (20) (Types: MERCEDES 4 AXLE)

- Hammers (5) (Types: CAT 330)
- Drilling machinery (5) (Types: TAMROC RANGER)
- Graders (2) (Types: CAT 14G, CAT 14H)
- Crushing stones plants (2) (Types: LOKOTRACK 100, 258)
- Lubrication Trucks (3) (Types: ASTRA 4 AXLE)
- Water tank trucks (2) (Types: ASTRA 4 AXLE)
- Mobile crane trucks (2) (Types: ASTRA)

## 6. MATERIALS

The excavated materials will be classified to Soil – Semi rock and Rock Materials according to Technical Specifications paragraph 3.2.2 and the approved by the Engineer materials will be used for embankment construction.

## 7. DESCRIPTION OF THE METHOD

The sequence of the activities for the excavation works is stated below:

1. Preliminary works
2. Marking, Positioning and Topography surveying layout
3. Locating and positioning of the public utilities
4. Traffic regulations (if required)
5. Mobilization of mechanical equipment, machinery and plants
6. Allocation of permanent disposal areas approved by the local authorities (according to paragraph 3.2.5 of the Technical Specifications)
7. Classification of materials (according to paragraph 3.2.2 of the Technical Specifications)
8. Testing of local materials
9. Excavations of Top Soil (according to paragraph 3.1.2 of the Technical Specifications)
10. Excavations of Soil Semi rock
11. Drilling and Blasting techniques (according to paragraph 3.2.6 of the Technical Specifications)
12. Excavations of Rock materials
13. Construction method as stated
14. Implementation of the construction method (according to paragraph 3.1.2 of the Technical Specifications)



For more detailed analysis of the interrelated quality issues please see the Inspection Test plan for excavations

## 8. Risk assessment

Give a complete assessment about risks on labour's Health and Safety and on Environment per activity. The Risk assessment shall include the following information as minimum:

Activity / Operation	Health & Safety (S) and Environment (E) Hazards	Risk Seriousness	Preventive Measures	Technical or Organisational Measures to Control the Remaining Risk
Excavations	Worker falling into excavation	Major	Physical barriers to be erected at excavation edge. Ensure safe access to excavation. Do not allow works between the fence and the excavation. Fence is always at a minimum distance of 1m from excavation. Walking between fence and excavation is not allowed.	Supervisor to monitor
Excavations	Hit by equipment	Major	All stay at least 5 meters away from working area of equipment, including cabin and boom/bucket. All equipment have a visual and audio reverse alarm. Reverse alarm works properly. Equipment properly maintained. No personnel between equipment. No personnel between equipment and excavation if less than 10 meters. No personnel between equipment and fixed structure if less than 10 meters.	<ul style="list-style-type: none"> <li>Excavation activities under CONTINUOUS supervision by experienced personnel</li> <li>Licensed operator</li> </ul>
Excavations	Plant falling into excavation e.g. concrete terry overrunning edge of excavation	Major	Vehicle routes are planned. Provide secured stop blocks.	<ul style="list-style-type: none"> <li>Routes marked with Barricade or fencing</li> <li>Banksmen to assist in safe use of plant</li> <li>Foreman to check plant reports.</li> </ul>
Excavations	Risks of sides of 1.5m deep strip foundation of excavation collapsing (cave in)	Major	Carry out geotechnical study. All heavy traffic (loaded trucks, site equipment) will not come closer than 1.5m for depth up to 5m and 1.5 meters plus Hx0.1 for depth (H) bigger than 5.0 metres. Any relocation, side collapse to be immediately reported. Don't use excavation walls for access. Never cave in when excavating. Report any caving in. Spot	<ul style="list-style-type: none"> <li>1.5m deep excavation to be carried out and foundations poured in on the same day.</li> <li>Supervisor to monitor.</li> <li>Discipline Engineers to supervise Excavations.</li> <li>Discipline Engineer</li> </ul>

			heaps to be placed at least 1 meter from the excavation. Protect excavation from drain waters.	will study the safe support of the excavation sides based on soil properties and parameters such as near by structures, water level, depth of excavation, traffic, etc.
	Access and egress route	Major	Proper ladder (size and type) Ramps. Place accesses every 20 meters.	The ladder should extend 3 feet above the top of the excavation.

**NOTE:** The Risk assessment may be part of the Health and Safety Plan.

**APPENDIX I**  
**"INSPECTION AND TEST SCHEDULE FOR EXCAVATIONS"**

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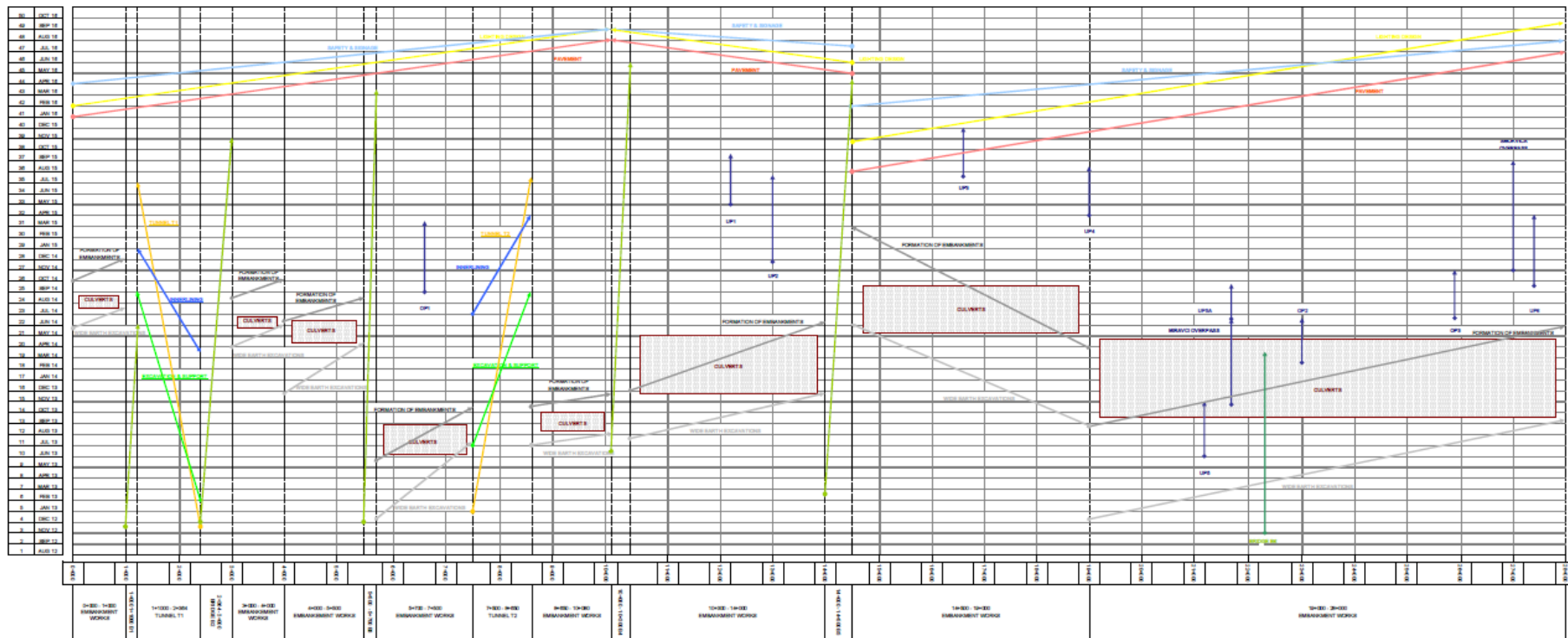
ITEM	ACTIVITY	NATURE OF CONTROL AND ACCEPTANCE CRITERIA	VERIFYING DOC	INSPECTION FREQUENCY	INSPECTION PROFORMA	RESPONSIBILITIES (✓, Hold, Check)							
						Earth works Eng	Geologist	Surveyors	Quality	Laboratory	Foreman	Cont.	Eng.
1.	Preliminary works										✓		
2.	Marking, Positioning and Topography surveying layout	DRAWINGS			RFI	✓		✓				H	C
3.	Locating and positioning of the public utilities					✓		✓			✓		
4.	Traffic regulations (if required)					✓		✓				H	C
5.	Mobilization of mechanical equipment, machinery and plants										✓		
6.	Designation of permanent disposal areas approved by the local authorities		Technical Specifications 3.2.5			✓		✓					



ITEM	ACTIVITY	NATURE OF CONTROL AND ACCEPTANCE CRITERIA	VERIFYING DOC	INSPECTION FREQUENCY	INSPECTION PROFORMA	RESPONSIBILITIES (✓, Hold, Check)							
						Earth works Eng	Geologist	Surveyors	Quality	Laboratory	Foreman	Cont.	Eng.
7.	Classification of materials		Technical Specifications 3.2.2		RFI	✓	✓			✓		H	C
8.	Testing of local materials		Technical Specifications 3.2.4		See ITS for lab tests, RFI					✓			
9.	Excavations of Top Soil		Technical Specifications 3.1.2		RFI						✓	H	C
10.	Excavations of Soil Semi rock		Technical Specifications 3.2.2		RFI						✓	H	C
11.	Drilling and Blasting techniques		Technical Specifications 3.2.6.1, 3.2.6.1		RFI	✓	✓	✓			✓	H	C
12.	Excavations of Rock materials				See ITS for lab tests, RFI	✓					✓	H	C
13.	Construction method as stated								✓				
14.	Implementation of the construction method		Technical Specifications 3.1.2						✓				
15	Non conformity and corrective actions (if required)			Is required	- Non-conformance Report (NCR) - Non-conformance list				✓			H	C

# TIME LOCATION DIAGRAM

Construction of new motorway section Denis Kaplja – Smolovica as part of the Pan-European Corridor X,  
Publication reference: EuropaAid/131018/DW/KSMK







# CASH FLOW PROJECTION

REV C  
DATE: 17-01-18

Construction of new motorway section Demir Kapija – Smokvica as part of the Pan-European Corridor X,  
Publication reference: EuropeAid /I31015/D/WKS/MK

Month	Value of work	Paid Value of Work	Advance Payment	Advance Repayment	Payments to Contractor excluding retention	
	[EUR]	[EUR]	[EUR]	[EUR]	Monthly Total	Cumulated Value
					[EUR]	[EUR]
SEP12						
OCT12	1.501.907,00					
NOV12	405.556,00					
DEC12	477.822,00		21.014.817,72		21.014.817,72	21.014.817,72
JAN13	348.201,00	2.733.486,00			2.733.486,00	23.748.303,72
FEB13	1.480.427,00					23.748.303,72
MAR13	1.658.628,00	3.139.055,00			3.139.055,00	26.887.358,72
APR13	1.681.146,00					26.887.358,72
MAY13	2.070.800,00	3.751.946,00			3.751.946,00	30.639.304,72
JUN13	2.540.247,00	2.540.247,00			2.540.247,00	33.179.551,72
JUL13	2.825.807,00	2.825.807,00			2.825.807,00	36.005.358,72
AUG13	3.225.736,00	3.225.736,00			3.225.736,00	39.231.094,72
SEP13	5.533.436,00	5.533.436,00		1.106.687,20	4.426.748,80	43.657.843,52
OCT13	6.888.884,00	6.888.884,00		1.377.776,80	5.511.107,20	49.168.950,72
NOV13	7.531.246,00	7.531.246,00		1.506.246,20	6.024.999,80	55.193.947,52
DEC13	3.993.595,00	3.993.595,00		798.719,00	3.194.876,00	58.388.823,52
JAN14	1.624.175,00					58.388.823,52
FEB14	4.111.570,00	5.735.745,00		1.147.149,00	4.588.596,00	62.977.419,52
MAR14	7.906.949,00	7.906.949,00		1.581.389,80	6.325.559,20	69.302.978,72
APR14	8.036.058,00	8.036.058,00		1.607.211,60	6.428.846,40	75.731.825,12
MAY14	8.358.697,00	8.358.697,00		1.671.739,40	6.686.957,60	82.418.782,72
JUN14	8.240.038,00	8.240.038,00		1.648.007,60	6.592.030,40	89.010.813,12
JUL14	8.679.253,00	8.679.253,00		1.735.850,60	6.943.402,40	95.954.215,52
AUG14	8.354.058,00	8.354.058,00		1.670.811,60	6.683.246,40	102.637.461,92
SEP14	8.303.598,00	8.303.598,00		1.660.719,60	6.642.878,40	109.280.340,32
OCT14	6.695.167,00	6.695.167,00		1.339.033,40	5.356.133,60	114.636.473,92
NOV14	6.209.158,00	6.209.158,00		1.241.831,60	4.967.326,40	119.603.800,32
DEC14	4.305.819,00	4.305.819,00		861.163,80	3.444.655,20	123.048.455,52
JAN15	2.052.408,00					123.048.455,52
FEB15	4.165.871,00	6.218.279,00		60.477,52	6.157.801,48	129.206.257,00
MAR15	7.420.689,00	7.420.689,00				136.626.946,00
APR15	6.219.524,00	6.219.524,00				142.846.470,00
MAY15	5.917.928,00	5.917.928,00				148.764.398,00
JUN15	5.956.457,00	5.956.457,00				154.720.855,00
JUL15	5.045.267,00	5.045.267,00				159.766.122,00
AUG15	4.648.676,00	4.648.676,00				164.414.798,00
SEP15	4.043.413,00	4.043.413,00				168.458.211,00
OCT15	3.135.727,00	3.135.727,00				171.593.938,00
NOV15	2.775.809,00	2.775.809,00				174.369.747,00
DEC15	1.079.561,00					174.369.747,00
JAN16	77.203,00					174.369.747,00
FEB16	1.008.747,00					174.369.747,00
MAR16	1.532.983,00	3.698.494,00			3.698.494,00	178.068.241,00
APR16	1.181.355,00					178.068.241,00
MAY16	1.117.054,00					178.068.241,00
JUN16	1.126.946,00	3.425.355,00			3.425.355,00	181.493.596,00
JUL16	1.068.367,00					181.493.596,00
AUG16	762.555,00					181.493.596,00
SEP16	529.563,00					181.493.596,00
OCT16	144.672,00	2.505.157,00			2.505.157,00	183.998.753,00
TOTAL	183.998.753,00	183.998.753,00	21.014.817,72	21.014.817,72	183.998.753,00	

